

the call state information associated with the calls. In particular, preservation of call features in addition to bearer connections requires that the alternate controller be supplied with call state information.

In order to provide call state information to an alternate controller, such

5 information can be stored in a database that can be accessed by all primary and alternate call controllers. However, establishing a common, redundant database can be expensive. In addition, such databases can create a data bottleneck, especially when a large number of controllers are accessing the database. Furthermore, such a solution is not very robust, as network failures can prevent call controllers from accessing the common database.

10 Another approach to providing call state information to alternate call controllers dynamically updates available alternate call controllers with call state information. That is, as call state information is generated or updated, that information is provided to the alternate call controller or controllers that would be contacted by the client if the primary call controller were lost. However, this approach adds overhead and complexity,

15 particularly as the number of call controllers available on a system increases. In addition, the alternate call controllers must be updated with call state information regarding all of the calls on the main controller. This can result in network congestion. In addition, the solution is not very robust, as network failures can prevent controllers from communicating with one another.

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SUMMARY OF THE INVENTION

The present invention is directed to solving these and other problems and disadvantages of the prior art. According to the present invention, call state information

is provided from the primary call controller to the client. The client stores the state information provided by the primary call controller. If the state of the call changes, updated call state information is provided to the client. In the event of a failure of the call controller or the signaling channel, the client may provide an alternate call controller with
5 the call state information, thus allowing the alternate call controller to provide the call features that had been provided by the primary call controller. The state information need not be in a format that the client understands and processes.

In accordance with an embodiment of the present invention, the file containing the call state information may be provided to the alternate call controller in response to a
10 query to the client made by the alternate call controller. In accordance with another embodiment of the invention, the file containing the call state information may be pushed from the client to the alternate call controller.

BRIEF DESCRIPTION OF THE DRAWINGS

15 **Fig. 1** depicts a realtime communication arrangement in accordance with an embodiment of the present invention;

Fig. 2 depicts the relationship of clients and call controllers in accordance with an embodiment of the present invention; and

Fig. 3 is a flow diagram illustrating the operation of a system in accordance with
20 an embodiment of the present invention.

DETAILED DESCRIPTION

With reference now to **Fig. 1**, a realtime communication arrangement 100 in accordance with an embodiment of the present invention is illustrated. In general, the communication arrangement 100 involves a number of communication terminals 104a-n interconnected to one another by a communication network 108. As can be appreciated by one of skill in the art, the communication network 108 may form the communication channel between two or more communication terminals 104 in communication with one another. Furthermore, it should be appreciated that a portion or portions of the communication network 108 may comprise analog and/or switched circuit networks, such as the public switched telephone network (PSTN), and that at least a portion of the communication network 108 comprises an IP communication network. As can also be appreciated by one of skill in the art, where an Internet protocol (IP) communication network 108 comprises a portion of a communication link proximate to a communication terminal 104, such a communication terminal 104 may comprise an IP telephone, video phone or computer.

With reference now to **Fig. 2**, the relationships between various clients 204 and call controllers 208 associated with an IP protocol communication network 200 are illustrated. In particular, as shown in **Fig. 2**, the clients 204 are generally interconnected to the call controllers 208 through the IP protocol communication network 200. As can be appreciated by one of skill in the art, the IP protocol communication network 200 may comprise all or part of the communication network 108, and thus the arrangement depicted in **Fig. 2** may comprise all or a portion of the system 100 illustrated in **Fig. 1**. Communications between clients 204 across the IP protocol communication network 200

may be in accordance with various communication protocols, including the H.323 protocol.

The clients 204 may be of various types. For example, as illustrated in **Fig. 2**, clients 204 may comprise one or more gateways 212. In general, a client 204 comprising a gateway 212 provides for an interconnection between a communication endpoint 104 (or to a non-IP protocol network) that is not capable of direct interconnection to the IP protocol communication network 108. Furthermore, the connection between a gateway 212 and a non-IP protocol communication endpoint 104 may be made through a direct interconnection, such as may be established over a switched circuit network.

A client 204 may additionally or alternatively comprise a communication terminal 104 capable of directly interconnecting to the IP communication network, referred to herein as an Internet protocol (IP) communication endpoint 216. In general, an IP communication endpoint 216 is capable of direct interconnection to the IP protocol communication network 108. Accordingly, examples of IP communication endpoints 216 include IP telephones or video phones, implemented either as hardware (e.g., an IP telephone) or as software (e.g., a soft phone) running in connection with a general purpose computer, computers that are operable to provide real-time audio, video, and/or data communications, or any other data endpoint.

The call controllers 208 are network nodes that function to facilitate or enable communications between clients 204 of the IP protocol communication network 200 to which the controllers 208 and clients 204 are interconnected. In particular, the call controllers 208 maintain call state information. Examples of call state information includes SIP and H.323 call state information generated in connection with real-time

communications over an IP protocol communication network 200. For instance, call state information may include call setup, tear down, address translation, and billing information. The call controllers 208 also function to control access to the IP protocol communication network 200. As can be appreciated by one of skill in the art, in a typical arrangement, a call controller 208 may function or be assigned as a primary call controller with respect to one or more clients 204. Alternatively or in addition, a call controller 208 can function as an alternate call controller for a number of communication endpoints 204.

With reference now to **Fig. 3**, the operation of a system in accordance with an embodiment of the present invention is illustrated. Initially, at step 300, a call signaling channel is established between a client 204 and a call controller 208. For example, a user associated with a first communication endpoint 104 comprising an IP communication endpoint 216 may request that a communication channel (i.e., a call) be established with a second communication endpoint 104. In connection with the request for a communication channel, the call signaling channel will be established between the client 204 and the call controller (e.g., first call controller 208a).

At step 304, a determination is made as to whether call state information is available. In general, call state information may comprise any information related to the communication channel itself, or to peripheral data associated with the communication channel. For example, call state information may identify the various endpoints associated with the communication channel, whether a communication endpoint 104 has been placed on hook, and call timer information. If no call state information is available, the system may idle at step 304. If call state information is available, a call state

information file is generated using the most recent call state information (step 308). The call state information file is then sent to the client 204 (step 312). In general, the call state information file is sent to each client 204 that has established a call signaling channel with the call controller 208 and that is associated with the communication channel in connection with which the call state information has been generated. As can be appreciated by one of skill in the art, while a communication channel is being set up or established, call state information may exist that is not associated with an established communication channel. However, such information may be maintained in a call information file in accordance with the present invention, in order to facilitate establishment of a requested communication channel should the client 204 become disconnected from an assigned controller 208. As can also be appreciated by one of skill in the art, the call controller 208 may, in addition to providing a file containing call state information to the client 204, maintain call state information conventionally. Examples of such state information include coverage timers, forwarding status, login status, previous connections to other parties, override code used on the call, call park information. In general any feature related information to the user on the call is stored, as well as any call specific information on what happened to the call or is allowed to happen to the call.

At step 316, the call state information file is stored on the client 204. Accordingly, a copy of the call state information, as represented by the call state information file, is directly accessible to the client 204. However, it should be appreciated that the client 204 is not required to maintain any awareness of the format or contents of the call state information file.

At step 320, a determination is made as to whether updated call state information is available. If updated call state information is available, the system returns to step 308. If updated call state information is not available, a determination is made as to whether the call signaling channel between the client 204 and the call controller 208 has been terminated (step 324). If the call signaling channel has not been terminated, the system returns to step 320. If the call signaling channel has been terminated, a determination is next made as to whether the termination of that call signaling channel is valid (step 328). If the termination is determined to be valid, the procedure ends. An example of a valid termination is after the client 204 has gone on hook and the associated communication channel has been torn down.

If the termination of the call signaling channel was determined at step 328 to be invalid, an alternate call controller is selected (step 336). For example, the client 204 may select an alternate call controller 208 from a list of valid alternate call controllers 208 maintained on the client 204 or accessible to the client 204 over the IP protocol communication network 108. As can be appreciated by one of skill in the art, if the alternate call controller 208 that is initially selected is not available, a next call controller 208 may be selected. As a further example, the client 204 may broadcast a request for a call controller 208, and may select a responding call controller 208 as an alternate -call controller 208. At step 340, the client 204 contacts the alternate call controller 208. The call state information file is then passed from the client 204 to the alternate call controller 208 (step 344). The call state information file may be passed to the alternate call controller 208 by the client 204 as part of or in connection with establishing contact with the alternate call controller 208. Furthermore, the call state information file may be

pushed to the alternate call controller 208 by the client 204. Alternatively, the call state information file may be provided to the alternate call controller 208 in response to a query for that file made by the alternate call controller 208.

After the call state information has been provided to the alternate call controller 208, the system may return to step 320. Furthermore, provided that information concerning all of the applicable call features in effect immediately prior to the loss of the call signaling channel with the primary or prior call controller 208 is contained in the call information file, all of those features may be maintained, even though the call has migrated from the primary call controller 208 to an alternate call controller 208.

Although the discussion provided herein has primarily described the use of call state information files to maintain call features associated with communication channels where a call signaling channel is lost, it should be appreciated that the present invention is not so limited. For example, the present invention may also be used to maintain call features applicable to a communication channel where a connection between a client 204 and a call controller 208 is intentionally brought down. For instance, the present invention may be used to maintain call features associated with communication channels in existence at the time that a call controller 208 is removed from service for maintenance or upgrading.

Furthermore, it should be appreciated that the present invention may be applied in connection with any IP real-time transfer protocol (RTP) stream. Therefore, although the description provided herein refers to calls and to the use of call controllers, it should be appreciated that the present invention is not limited to voice telephony applications.

The present invention, by applying a “cookie” type technique in order to save call state information increases the natural network reliability by distributing such information. In addition, the disclosed invention is highly scalable, as clients 204 store their own call state information, avoiding the need for sending updated call information to a central database or to alternate call controllers. Further, call state information is only sent to alternate controllers when such information is needed. In addition, the disclosed invention is simple to implement and requires relatively few resources. Also, because embodiments of the present invention do not require that clients 204 be capable of recognizing the content of call state information files, changes can be made to the structure and content of these files, without requiring changes to the clients 204. Instead, only call controllers 208 need to be capable of reading the content of the call state information files.

The foregoing discussion of the invention has been presented for purposes of illustration and description. Further, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the above teachings, within the skill and knowledge of the relevant art, are within the scope of the present invention. The embodiments described hereinabove are further intended to explain the best mode presently known of practicing the invention and to enable others skilled in the art to utilize the invention in such or in other embodiments and with various modifications required by their particular application or use of the invention. It is intended that the appended claims be construed to include the alternative embodiments to the extent permitted by the prior art.